

# **National Information Exchange Model (NIEM): DoD Adoption and Implications for C2**

---

**Dr. Scott Renner**

**Presented at 19th International Command and Control  
Research and Technology Symposium (ICCRTS)**

**18 June 2014**

**Approved for Public Release;  
Distribution Unlimited.  
Case Number 14-2040**

**MITRE**

© 2014 The MITRE Corporation. All Rights Reserved.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>JUN 2014</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2014 to 00-00-2014</b>	
4. TITLE AND SUBTITLE <b>National Information Exchange Model (NIEM): DoD Adoption and Implications for C2</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>MITRE,7525 Colshire Drive,McLean,VA,22102-7539</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>Presented at the 18th International Command &amp; Control Research &amp; Technology Symposium (ICCRTS) held 16-19 June, 2014 in Alexandria, VA. U.S. Government or Federal Rights License</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>39</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

# Outline

---

- **Background: DoD Net-Centric Data Strategy (NCDS)**
- **NIEM and data interoperability**
- **Adopting NIEM in the DoD**

# Net-Centric Warfare: Rationale for NCDS

## ■ Seamless interoperability

- Data interoperability is included

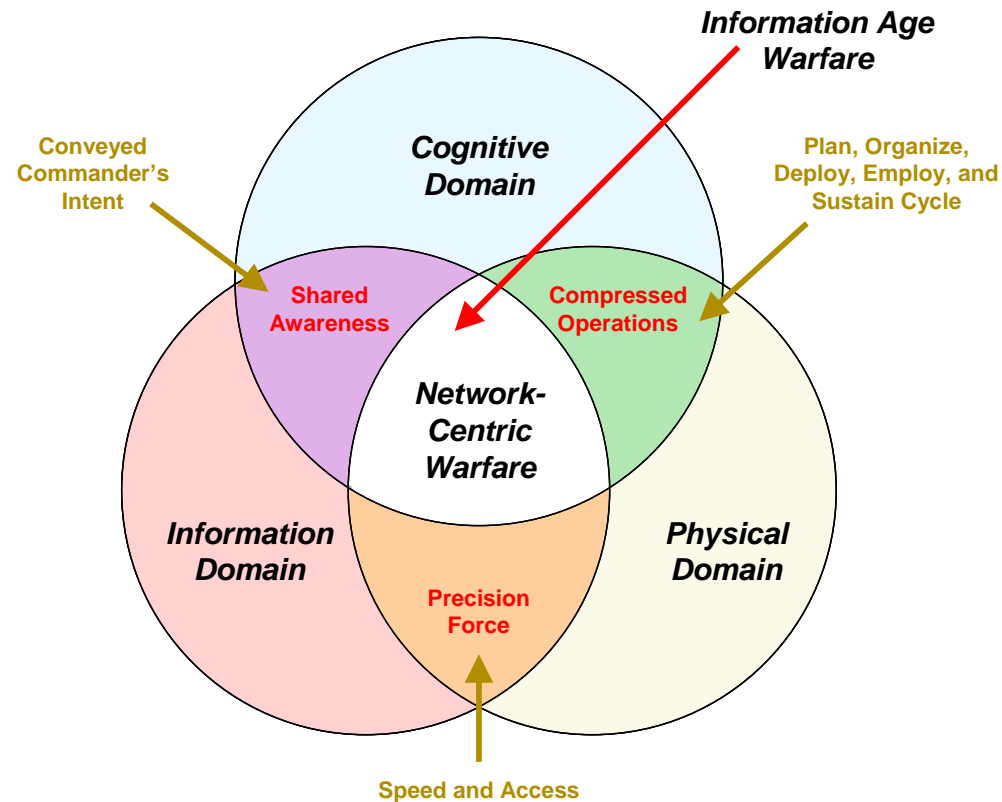
## ■ Permits sharing of

- Information
- Situational awareness
- Commander's intent

## ■ Leading to

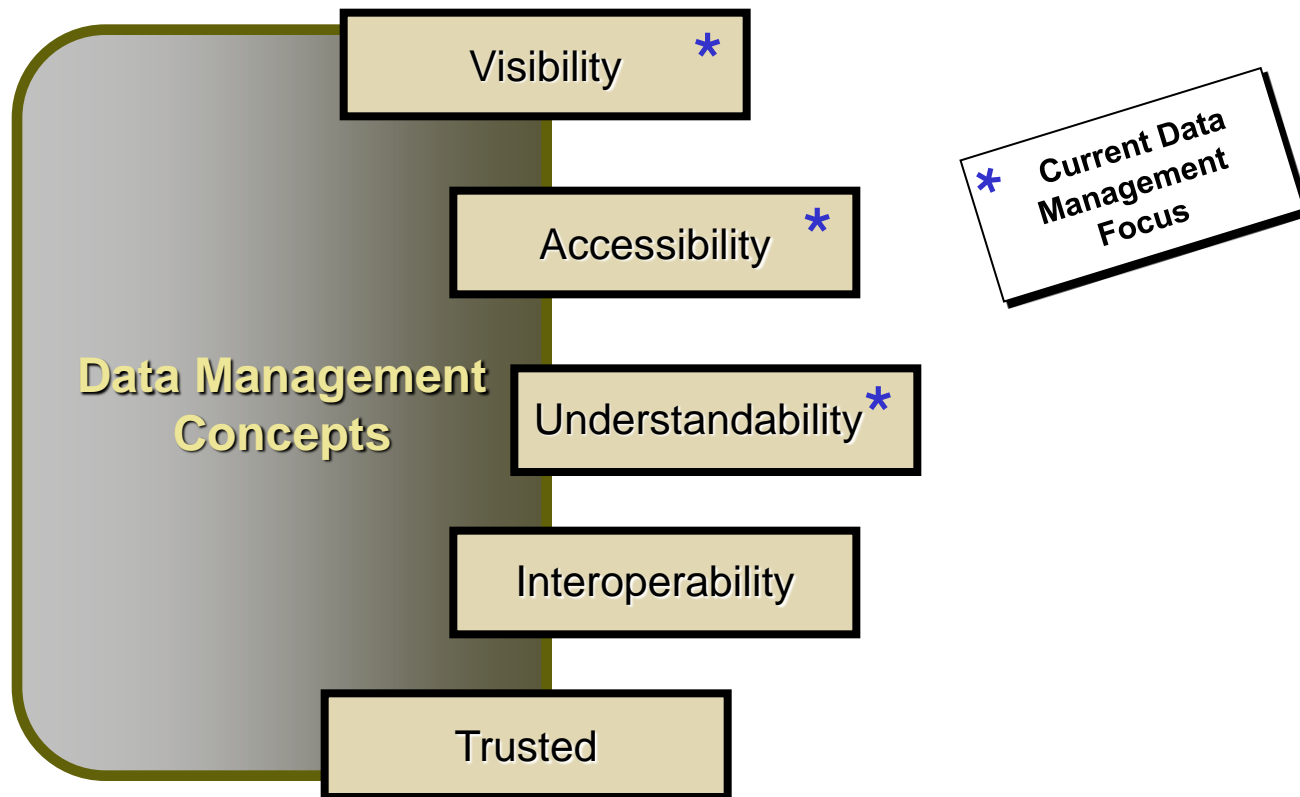
- Speed of command
- Self-synchronization
- Enemy lock-out

## ■ Producing increased combat power



*NCW: Creating A Decisive Advantage*  
ASD/NII, Office of Force Transformation

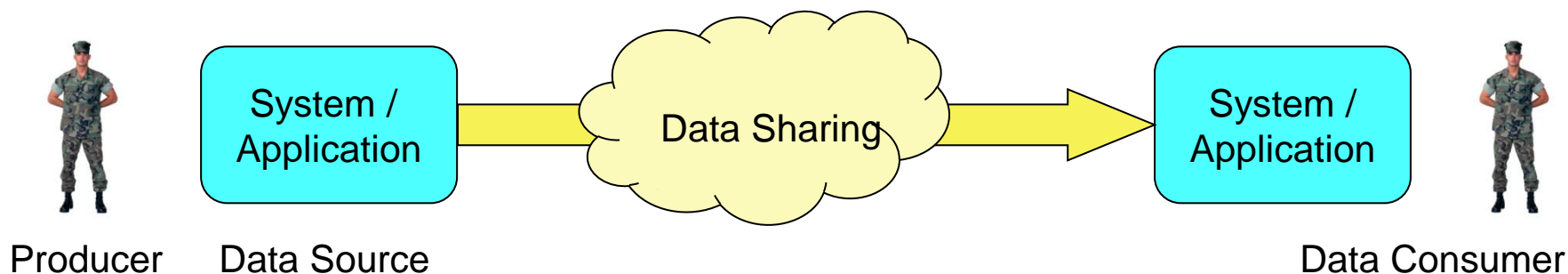
# DoD Net-Centric Data Strategy: Goals



*Power to the Edge* ~~~~~

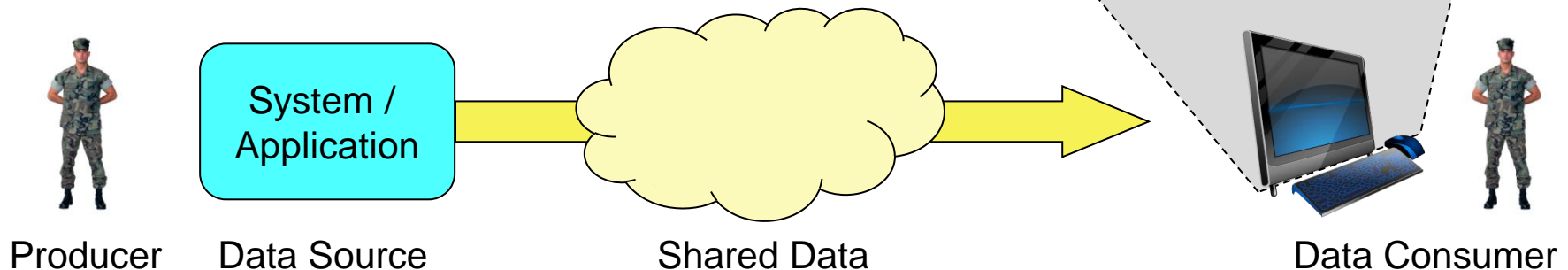
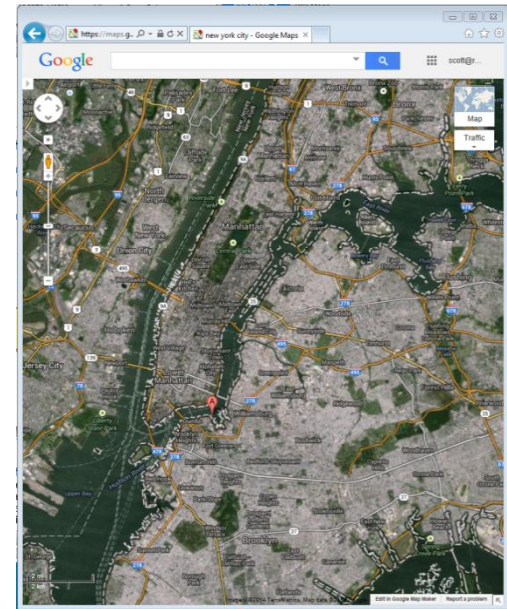
# Data Sharing

- **Visible** Can the consumer discover the source?
- **Accessible** Can he obtain the source content?
- **Understandable** Can he know what the content means?
- **Trusted** Can he believe what the content says?
- **Interoperable** . . .



# Sharing for User Presentation

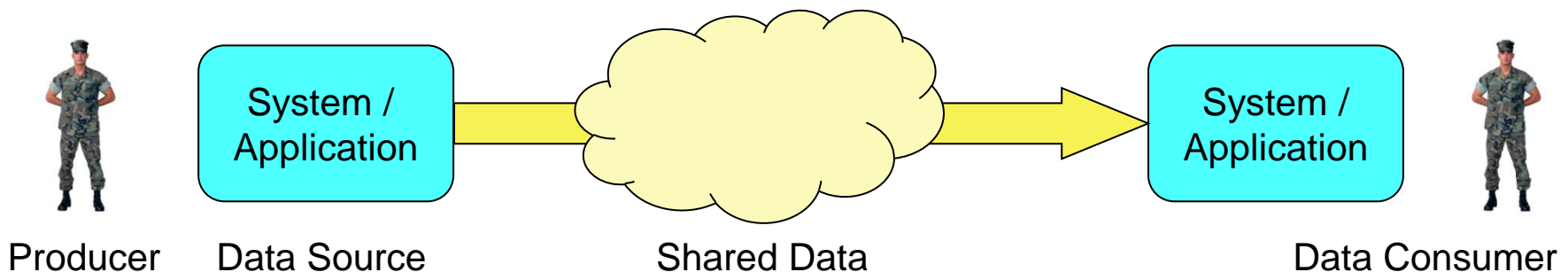
- Sometimes the purpose of the sharing is to display data to the human consumer
  - Images, maps, text documents
  - Data that is understood and interpreted by the human user
  - Consumer's application often like a web browser



# Sharing for Machine Consumption

- **Sometimes the purpose is to provide input to an automated process**
  - Data is never seen by the human user
  - Data interpreted according to the assumptions of the software developer
  - Developers don't see the data at runtime, either, so their understanding better be correct!

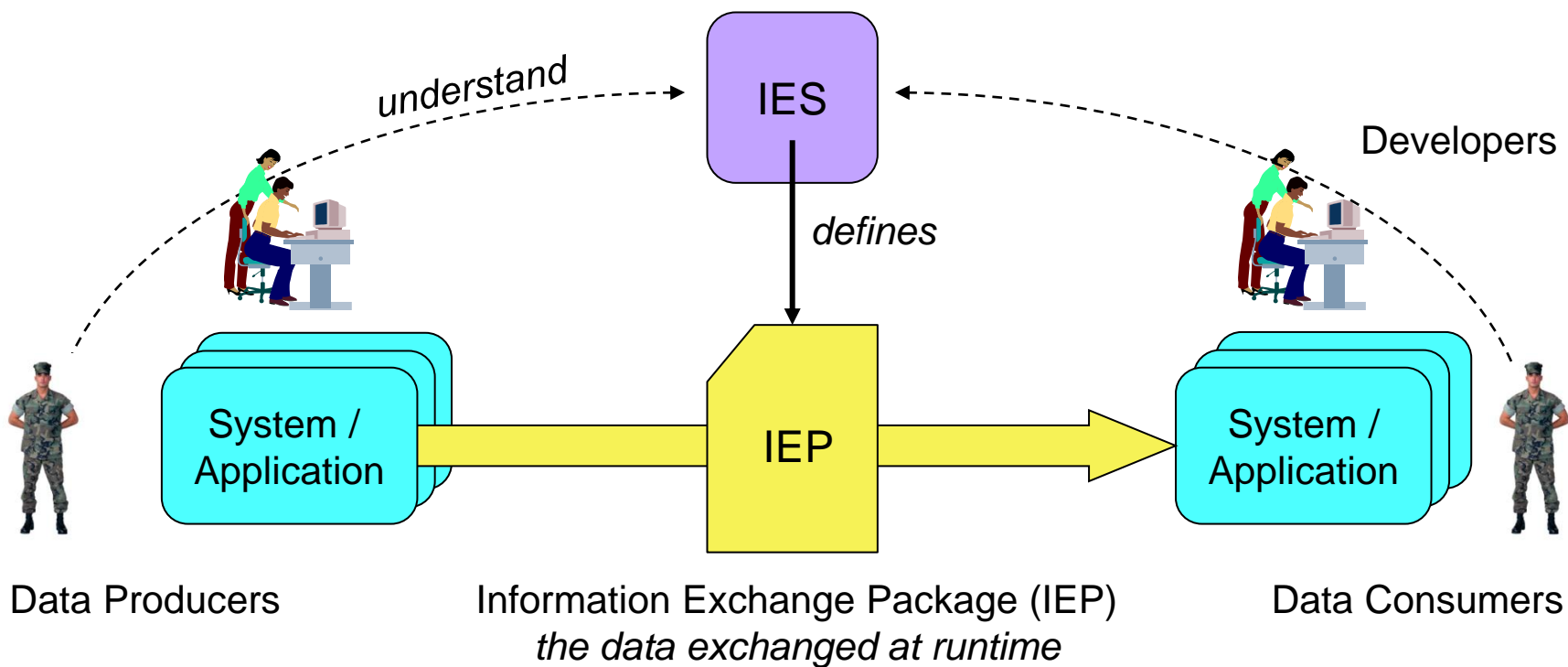
Developers



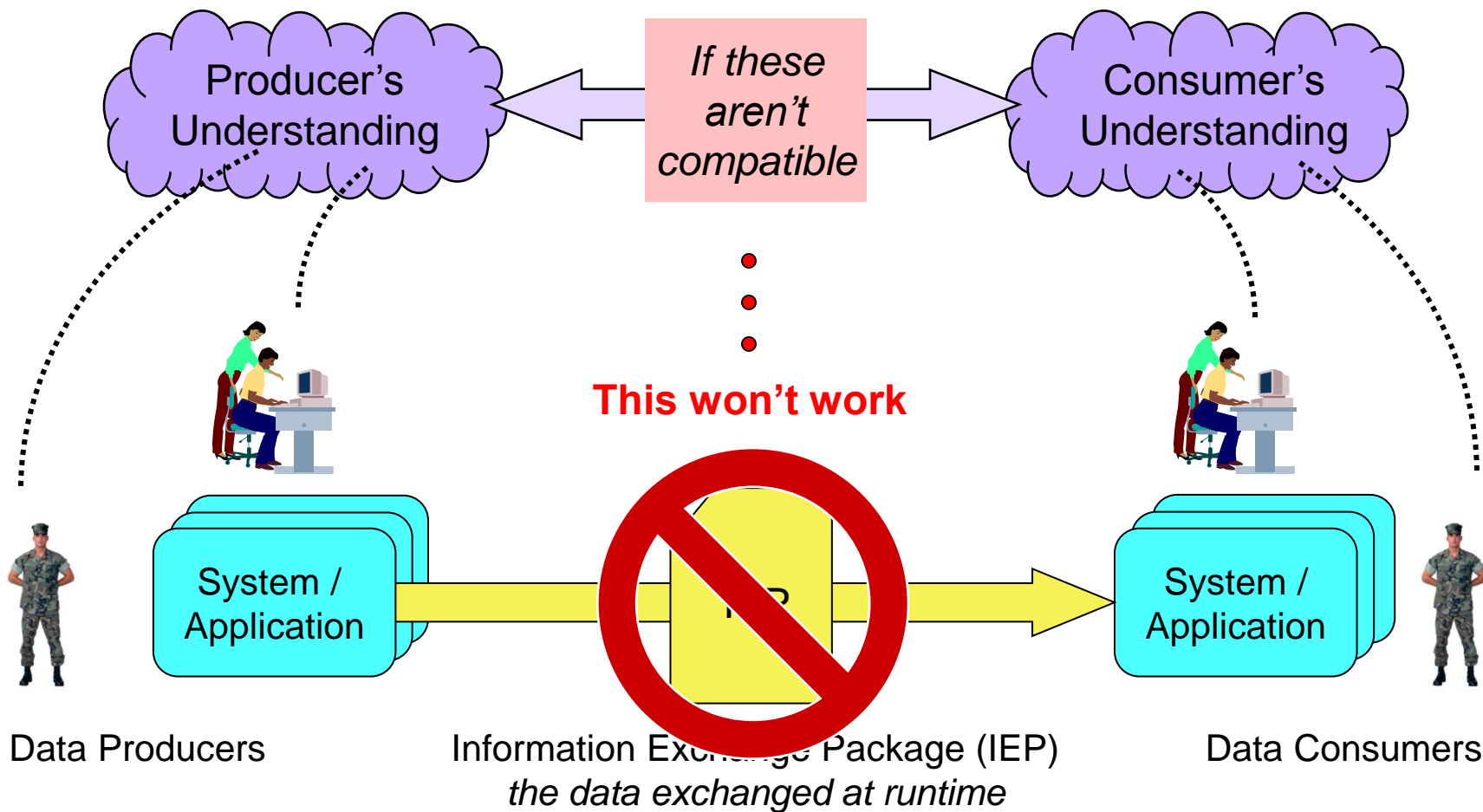


# Data Interoperability

Information Exchange Specification (IES)  
*build-time description of the data to be exchanged*



# Data Interoperability Problem



# Outline

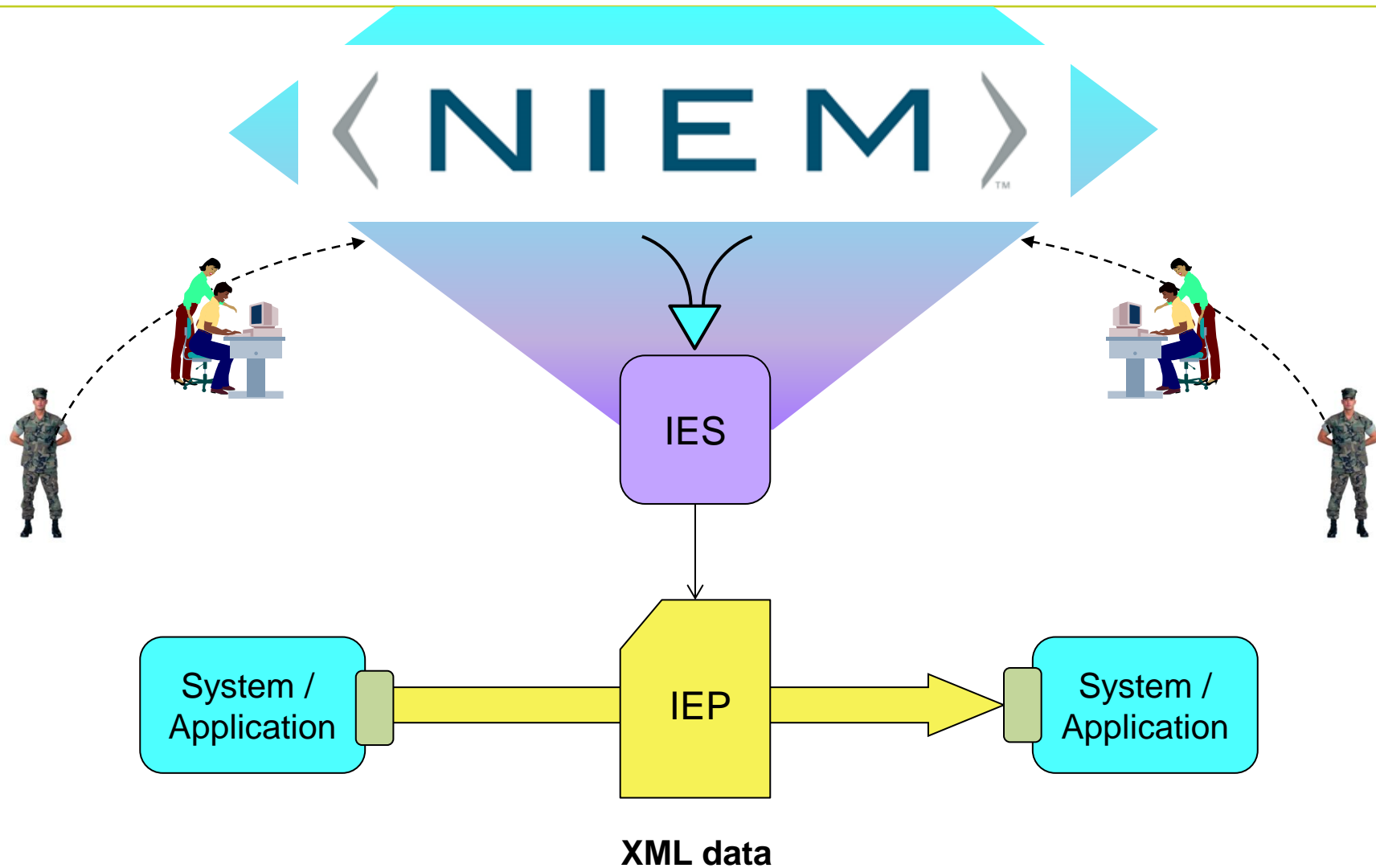
---

- Background: DoD Net-Centric Data Strategy (NCDS)

- ➡ NIEM and data interoperability

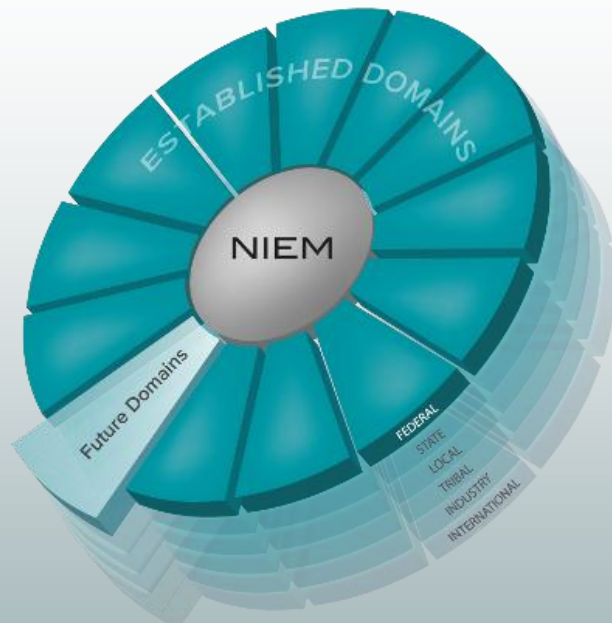
- Adopting NIEM in the DoD

# A Standards-Based Approach for IES Design



# HOW NIEM WORKS

## Common Language (Community-driven Data Model)



Built and governed by the business users at Federal, State, Local, Tribal, International and Private Sectors

## Repeatable, Reusable Process (Information Exchange Development Lifecycle)

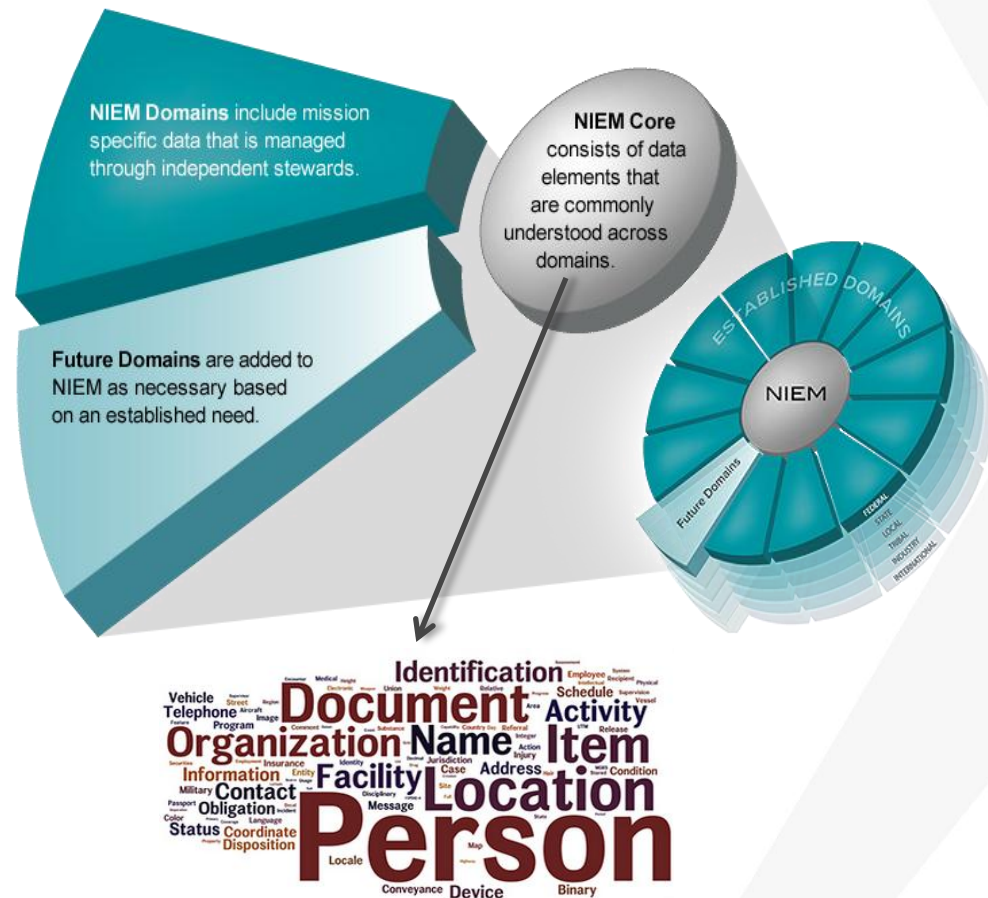


# MODEL OVERVIEW

Think of the NIEM data model as a mature and stable data dictionary of agreed-upon terms, definitions, and formats independent of how information is stored in individual agency systems.

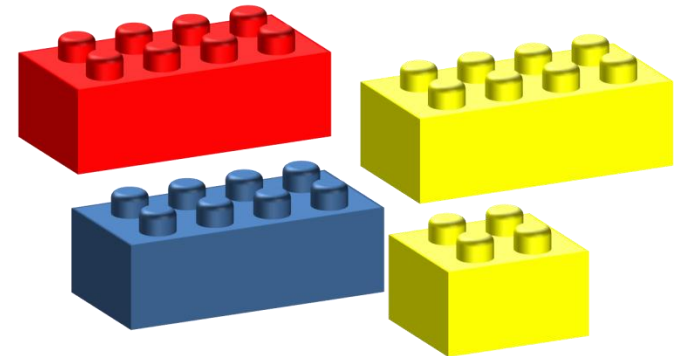
The data model consists of two sets of closely related vocabularies: **NIEM Core** and individual **NIEM Domains**.

- Biometrics
- Chemical, Biological, Radiological, & Nuclear
- Cyber (*emerging*)
- Children, Youth, and Family Services
- Emergency Management
- Health (*emerging*)
- Human Services (*emerging*)
- Immigration
- Infrastructure Protection
- Intelligence
- International Trade
- Justice
- Maritime
- Military Operations
- Screening



# “Lego™ Block” Modeling

- **Designing an information exchange with NIEM is like building a plastic model out of Lego blocks**
  - You decide what the model should look like
  - You choose the blocks you need for your model
  - Technical specification ensures that the blocks will snap together
- **NIEM is even better than Legos, because**
  - Each NIEM domain provides a collection of useful blocks
  - You can easily create any block that’s missing from your set (and then share it with others)
  - The blocks are all free

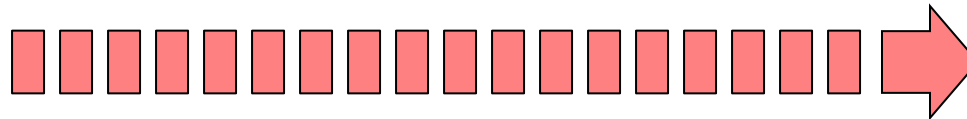


# Using the NIEM Approach To Satisfy An Information Exchange Need

Start with an information exchange need. You don't have to know all of the participants in advance. It's enough to know that the producer has data that needs to be shared with someone



Producers



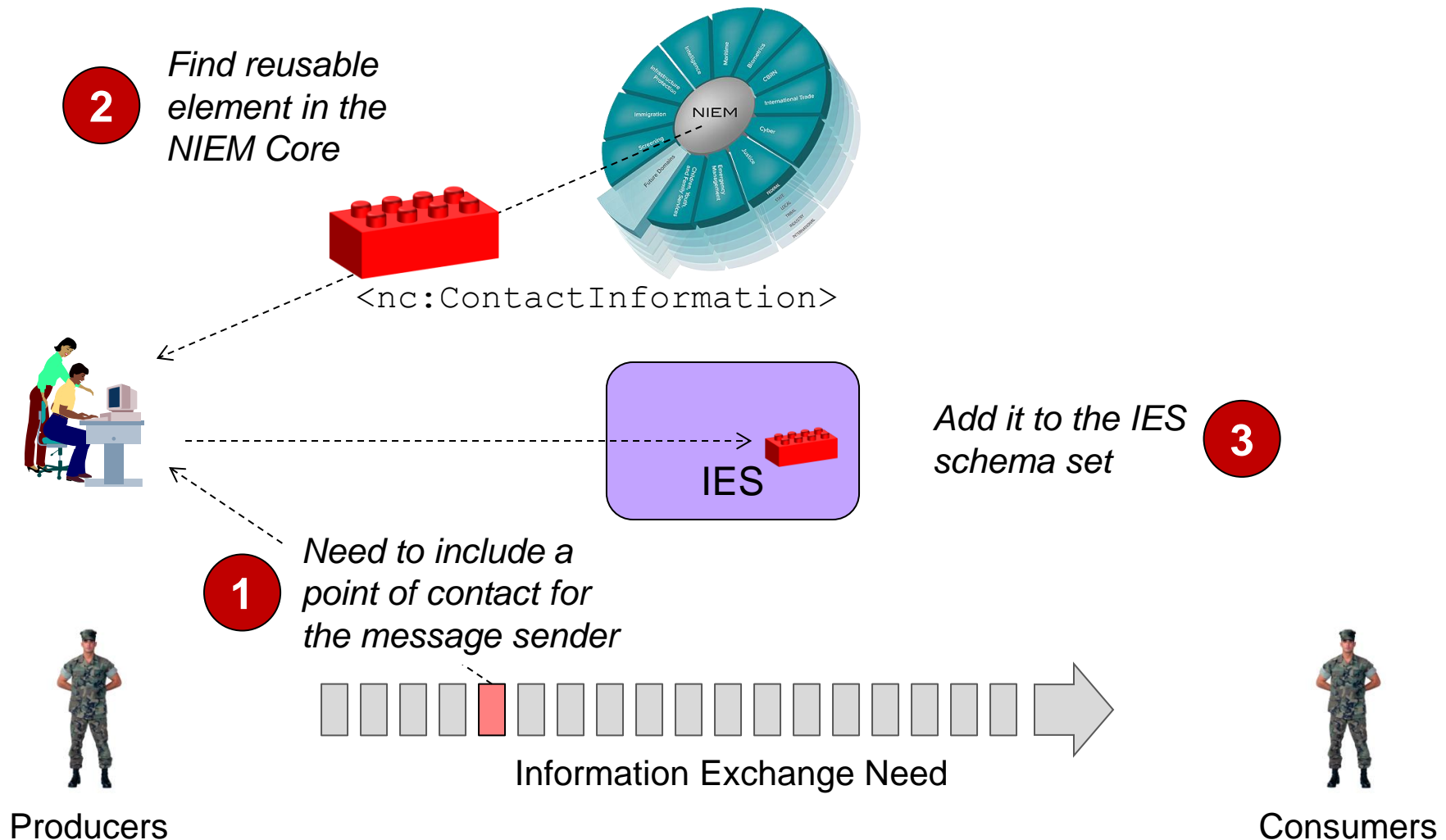
Information Exchange Need



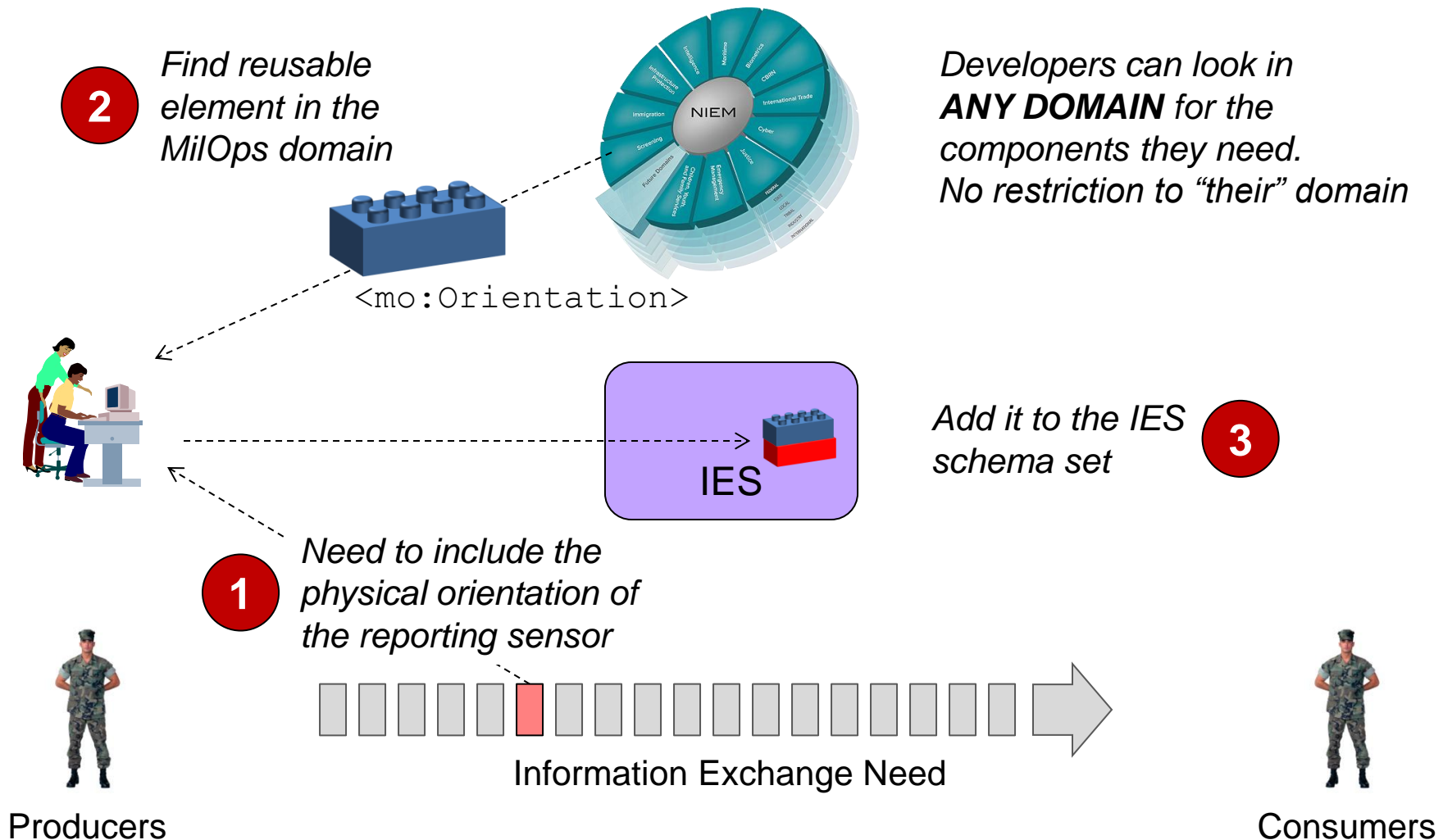
Consumers



# Designing the Exchange Specification: Find Core Components for Data Needs



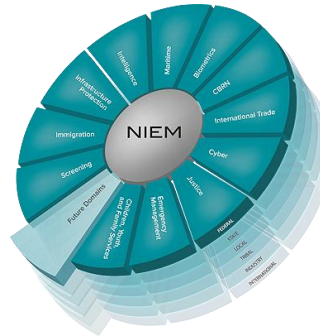
# Designing the Exchange Specification: Find Domain Components for Data Needs



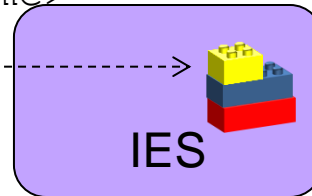
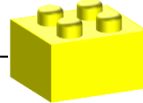
# Designing the Exchange Specification: Create New Components for Data Needs

2

*Can't find a matching component in core or domains*



`<cot:SensorModelName>`

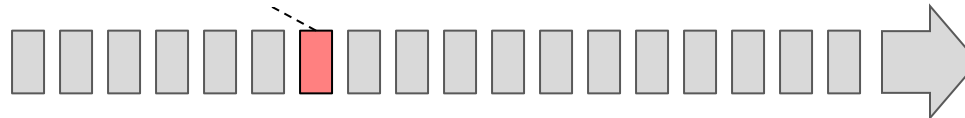


*Create and add a new component to the schema set*

3

1

*Need to include the model name of the reporting sensor*



Information Exchange Need



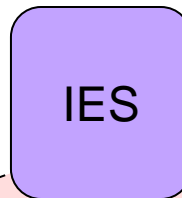
Producers



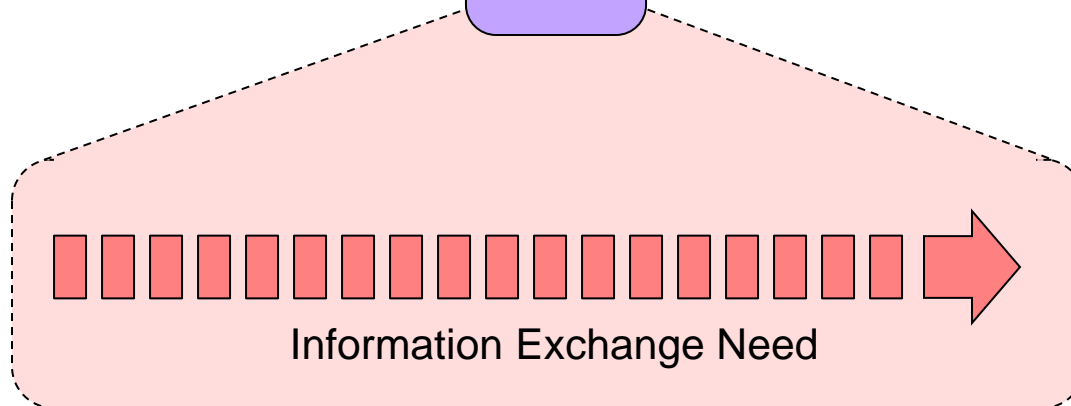
Consumers

# A Completed Exchange Specification

The IES is done when the XML Schema set includes a representation for all aspects of the exchange need



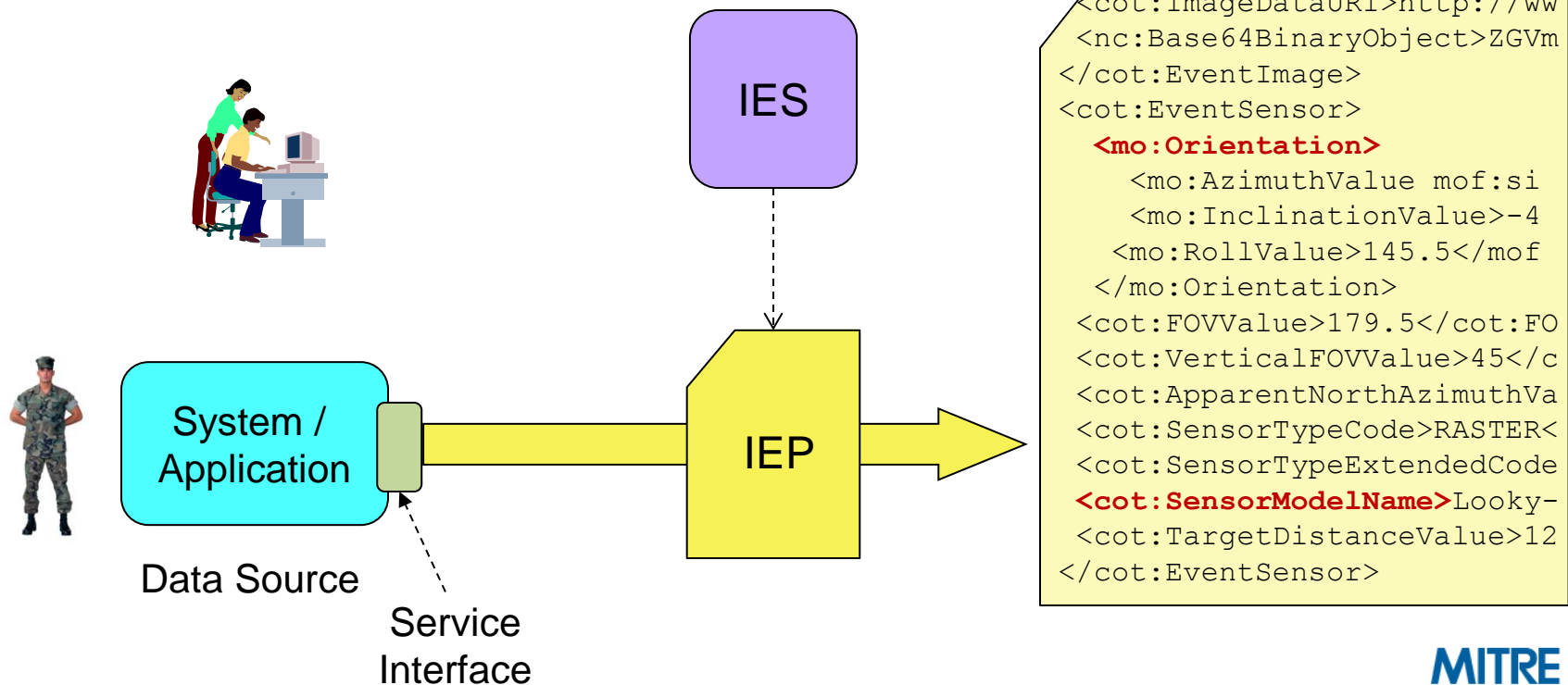
Producers



Consumers

## Implementing the Exchange Specification: Producer's Service Interface

Developers write **code to export the source's data**, in the form of XML data that conforms to the IES

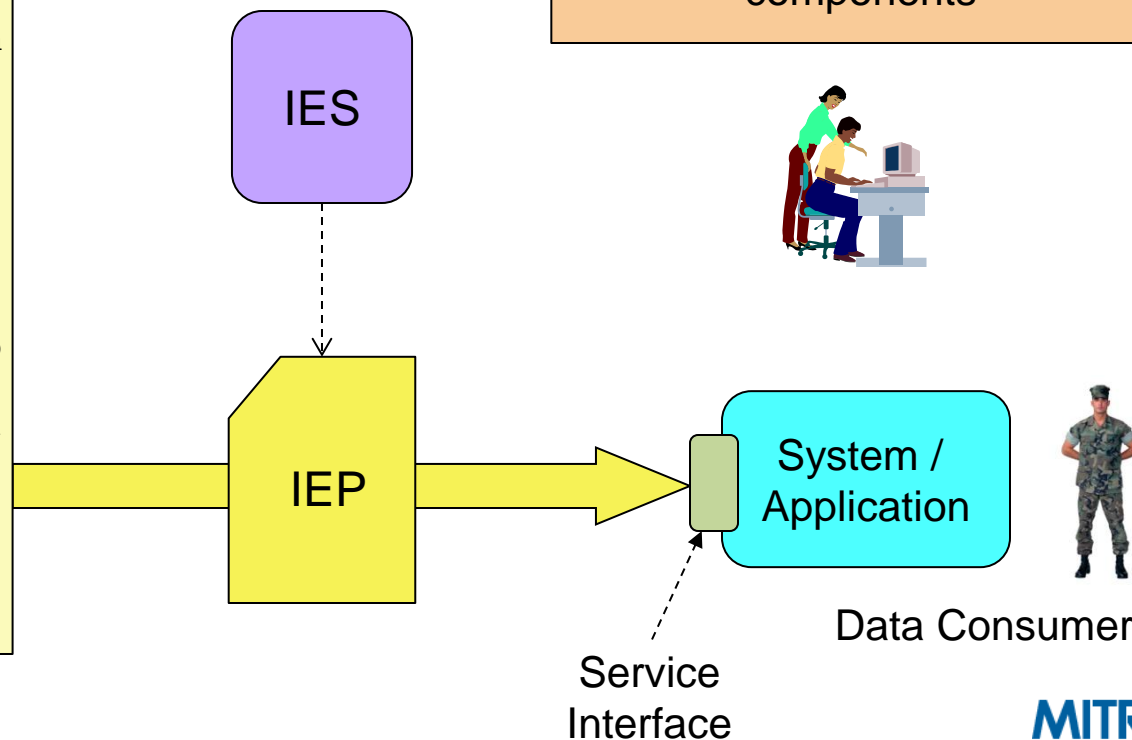


# Implementing the Exchange Specification: Consumer's Service Interface

```

    <ImageQualityText>Good</
    <ApparentNorthAzimuthVa
    <ImageDataSizeValue>50<
    <ImageDataURI>http://ww
    <Base64BinaryObject>ZGVm
    </cot:EventImage>
    <cot:EventSensor>
      <mo:Orientation>
        <mo:AzimuthValue mof:si
        <mo:InclinationValue>-4
        <mo:RollValue>145.5</mof
      </mo:Orientation>
    <cot:FOVValue>179.5</cot:FO
    <cot:VerticalFOVValue>45</c
    <cot:ApparentNorthAzimuthVa
    <cot:SensorTypeCode>RASTER<
    <cot:SensorTypeExtendedCode
    <cot:SensorModelName>Looky-
    <cot:TargetDistanceValue>12
    </cot:EventSensor>
  
```

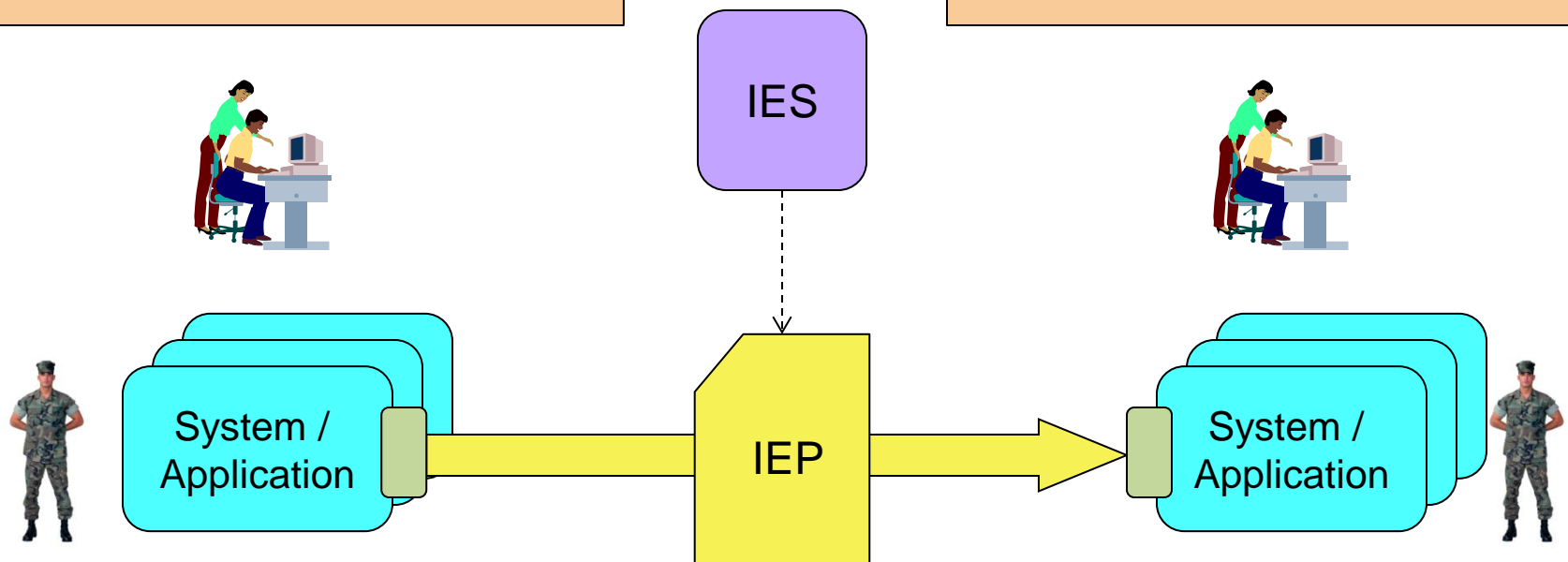
Developers write **code to process messages** which follow the IES. Part of their work is already done because they understand the NIEM Core and domain data components



# Implementing the Exchange Specification

Other producers and consumers may join at any time, in any order, by implementing the IES.

By following the NIEM standards-based approach, this machine-to-machine data exchange can be implemented in less time and at lower cost



# Data Exchanges Provide Data Interoperability

- NIEM is emphatically not a single comprehensive data model for all data exchanges
- A system does not simply “implement NIEM” and thereby become completely interoperable with every other system “implementing NIEM”
- A system can implement a particular NIEM-conforming information exchange specification
- All systems implementing a particular IES are interoperable with each other, for that exchange

**In NIEM, interoperability is defined at the IES level**



# NIEM Is . . .

## A Community

Formal Governance Processes

Self-Managing Domain Stewards

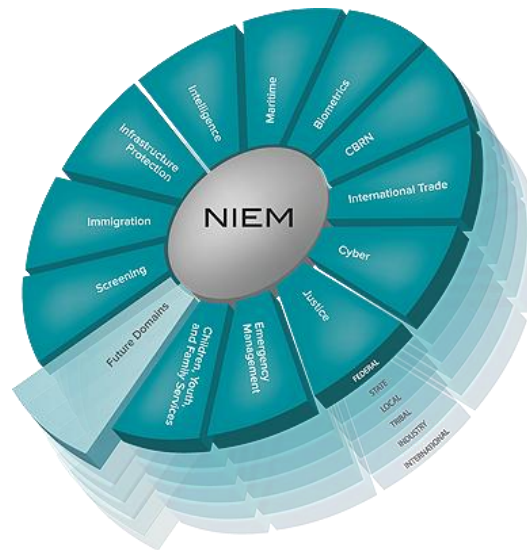
Help Desk & Knowledge Center

Established Training Program

Technical Specifications

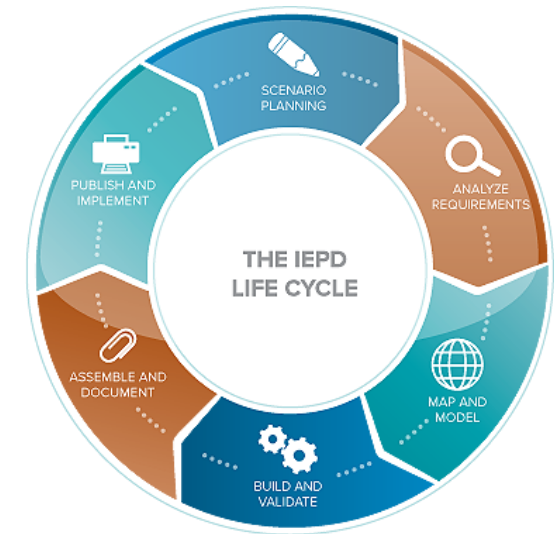
Vendor Tool Support

## A Data Model



*organized as a core plus subject-area domains, expressed as reusable XML Schema components*

## A Reusable Process



*for designing information exchange specifications by reusing XML Schema components*

# NIEM Is Going International

## ■ Canada: Using NIEM

- Temporary Resident Biometrics Project
- Entry/Exit Data Exchange
- These NIEM-based data exchanges are in operations today

## ■ United Kingdom: Considering NIEM

- US-UK evaluation by Data Support Team under the Interoperability Commission Working Group

## ■ NATO: Considering NIEM

- US proposing NIEM for NATO Core Data Framework (NCDF)
- NCDF is the emerging information exchange solution for NATO funded C2 programs and partner countries C2 systems.
- NCDF supports Federated Mission Networking (FMN) and Mission Partner Environment (MPE) information sharing goals.

## ■ Australia, European Union: Considering NIEM

# Outline

---

- **Background: DoD Net-Centric Data Strategy (NCDS)**

- **NIEM and data interoperability**

-  **Adopting NIEM in the DoD**

# DoD Adoption of NIEM

## PHASE 1: SHAPE

- *DOD CIO Intent Memo on NIEM Adoption* ✓
- Engage with internal/external audiences ✓
- *DOD policy issuances* ✓
- Synchronize with other DOD related activities ✓
- *Identify and conduct Pilots* ✓

## PHASE 2: IMPLEMENT

- *Establish NIEM MilOps domain* ✓
- NIEM Technical Assistance
- *Publish program implementation guidance*
- Incorporate into DOD governance framework ✓

## PHASE 3: MAINTAIN

- Developers implement consistent with NIEM First *policy*
- Measure adoption progress

# “Consider NIEM First” Policy

---

- **The key driver in DoD adoption is “Consider NIEM First”**
- **The “NIEM First” rule tells the program developers to either:**
  - Provide a NIEM-based interface for every **new** exchange, or
  - Obtain an exception for their preferred alternative approach
- **Exceptions are granted by the DoD CIO**
  - Justified by the business case for the alternative
  - Through a process that is simple and easy as it can be

# NIEM Is Not Required For Every Exchange

- **You don't have to retire existing non-NIEM exchanges**
- **You don't have to replace an existing data exchange just to make it conform to NIEM**
  - Even if you are modernizing the implementing system
  - So long as the exchange specification doesn't change
- **You can use any standard you like for a new exchange**
  - Either by obtaining an exception
  - Or by providing a NIEM interface along with your favorite

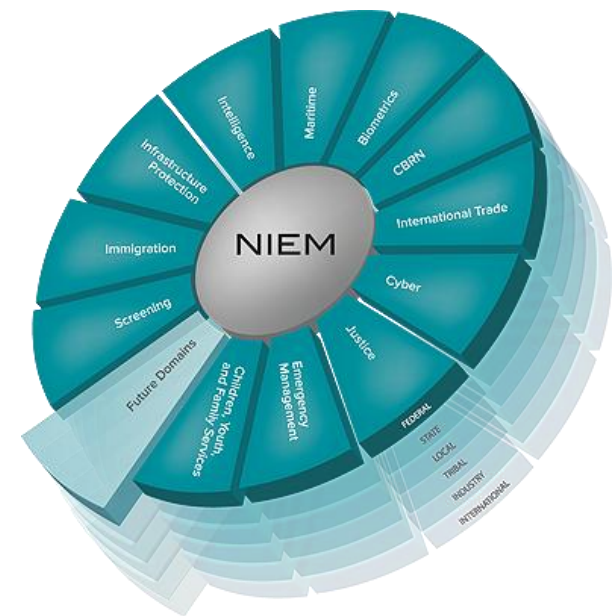
# Applying NIEM Is Not Technically Difficult

---

- **Developers with the skills to design and implement an XML data exchange can learn the NIEM approach in a matter of hours**
- **Developer training is available**
  - No-cost online courses are on the NIEM web site
- **Plenty of example IEPDs to follow**
- **The NIEM technical specifications are complex, however**
  - Most developers do not need to read them
  - Free tools can perform most of the conformance checking

# NIEM Is About Cooperation, Not Control

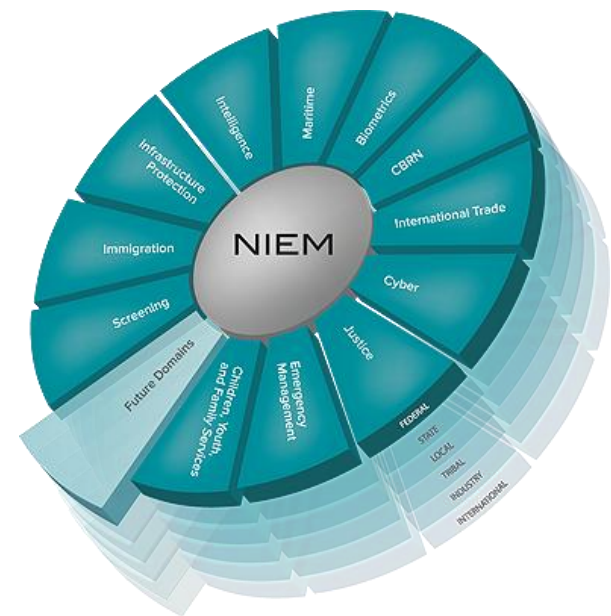
- **NIEM Core and NIEM domains create data components by consensus among data exchange designers**
- **Components are established when participants believe that a common definition will make their exchanges easier to create and implement**
- **Each domain changes on its own schedule, under its own control**
- **Changes in the core or in a domain do not force changes in other domains or in any data exchange**
- **No one is ever required to use a component that does not satisfy the data exchange needs, so there is no leverage for controlling the participants**





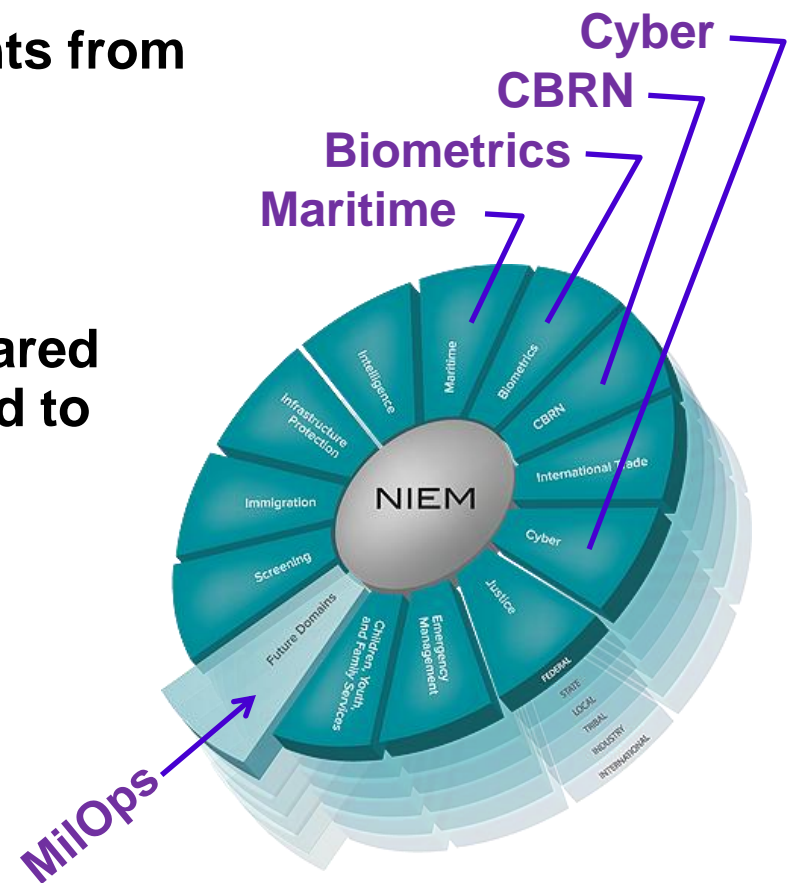
# “The Data Exchange Designer Is King”

- Nothing in NIEM or any NIEM domain can ever dictate the information content of any data exchange
- NIEM rules for extension and reuse guarantee that every exchange designer will always be able to specify the exact information needed by his exchange participants
- If you want more control over your enterprise or community, you must layer that governance on top of NIEM
- NIEM will work with
  - The agreement you can achieve
  - The flexibility you need to have
  - The control you choose to impose (within scale limits on vocabulary size)



# NIEM in DoD ≠ MilOps Domain

- **DoD involvement in NIEM goes far beyond scope of MilOps**
  - DoD is already involved in several NIEM domains
- **DoD developers will use components from any domain, not just from MilOps**
- **MilOps domain does not “approve” any data exchange design**
- **MilOps domain contains useful, shared data definitions for concepts related to military operations**
  - Harmonized with NIEM Core and other domains
  - Avoid duplicating content found in other domains



# NIEM Works In Low-Bandwidth Environment

- **Efficient XML Interchange (EXI) is the W3C standard for compressed binary XML data**
- **For a properly designed schema, EXI produces messages very near the information-theoretic minimum size**
  - Often smaller than hand-crafted binary message formats
  - Plenty of experimental evidence
- **Properly-designed schemas are always possible with NIEM**
  - Nothing in NIEM ensures a good low-bandwidth design, but...
  - Nothing in NIEM makes a good design impossible, and...
  - In practice, good design with NIEM is not difficult

**People will always have bandwidth problems,  
but these problems will not be caused by NIEM**

# NIEM Will Work in C2 Message Standards

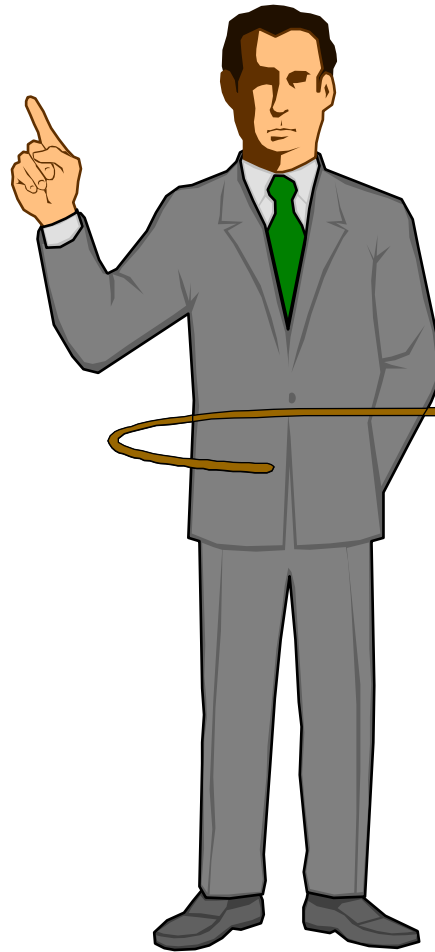
- **NIEM can be used for text and binary C2 message formats**
- **At first, define a NIEM equivalent to some existing messages**
  - When there is a need for the NIEM equivalent
  - Translate between existing and NIEM message at a gateway
  - Resulting NIEM message is easier for developers, easier to pass through security cross-domain guard
- **Later, message designers can create new messages using NIEM**
  - Use EXI when a compact binary form is required
- **Eventually, use NIEM to harmonize definitions across the message standard families**
  - Gradually, bottom-up, and only where cost effective

# Implications For C2

- No “big bang”, no disruptive transition to NIEM
- In FY15, DoD program managers begin to “Consider NIEM First” for new and substantially modified data exchanges
- Expect a slow and steady increase in the number of NIEM-based data exchanges
- C2 was a pathfinder for NIEM in the DoD  
Expect C2 programs among the early adopters
- Over time, you may see the US military message standards converging on the NIEM approach

# Summary

---



# Summary

---

- **NIEM is a standards-based approach for defining machine-to-machine data exchanges**
  - Repeatable process
  - Reusable components
  - Technical specifications and tool support
- **The DoD is adopting NIEM in order to help with the data interoperability goals in its Net-Centric Data Strategy**
- **Expect increased DoD participation in all NIEM domains (not just MilOps)**
- **Expect a slow and steady increase in NIEM-based data exchanges, beginning in FY15**

# For More Information

- **NIEM website:** [www.niem.gov](http://www.niem.gov)

- Domain content, training materials, technical specifications and tools

- **NIEM Technical Architecture Committee (NTAC)**

Scott Renner (NTAC Federal Co-Chair)

sar@mitre.org

+1 703-983-1206

- **DoD Adoption of NIEM**

Lynda Dallas

DoD Data Architect

DoD CIO / Information Enterprise / Architecture & Interoperability

lynda.b.dallas.civ@mail.mil

+1 571-372-7774

- **NIEM MilOps Domain**

Ryan Schultz

Domain Representative, NIEM Business Architecture Committee (NBAC)

Joint Staff J6 DDC4

ryan.r.schultz.civ@mail.mil

+1 757-203-5785